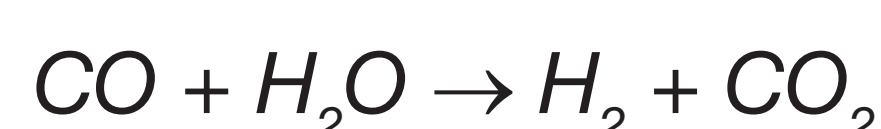


# CO<sub>2</sub> Control in IGCC Systems: H<sub>2</sub> Production from Coal with Integrated CO<sub>2</sub> Separation

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## Introduction

CO<sub>2</sub>-free production of electricity from fossil fuels can be done via a H<sub>2</sub>/CO<sub>2</sub>-separating reactors. At ECN we develop such reactors based on CO<sub>2</sub>- and H<sub>2</sub>-membranes or CO<sub>2</sub>-sorbents for the water-gas shift (WGS) reaction:

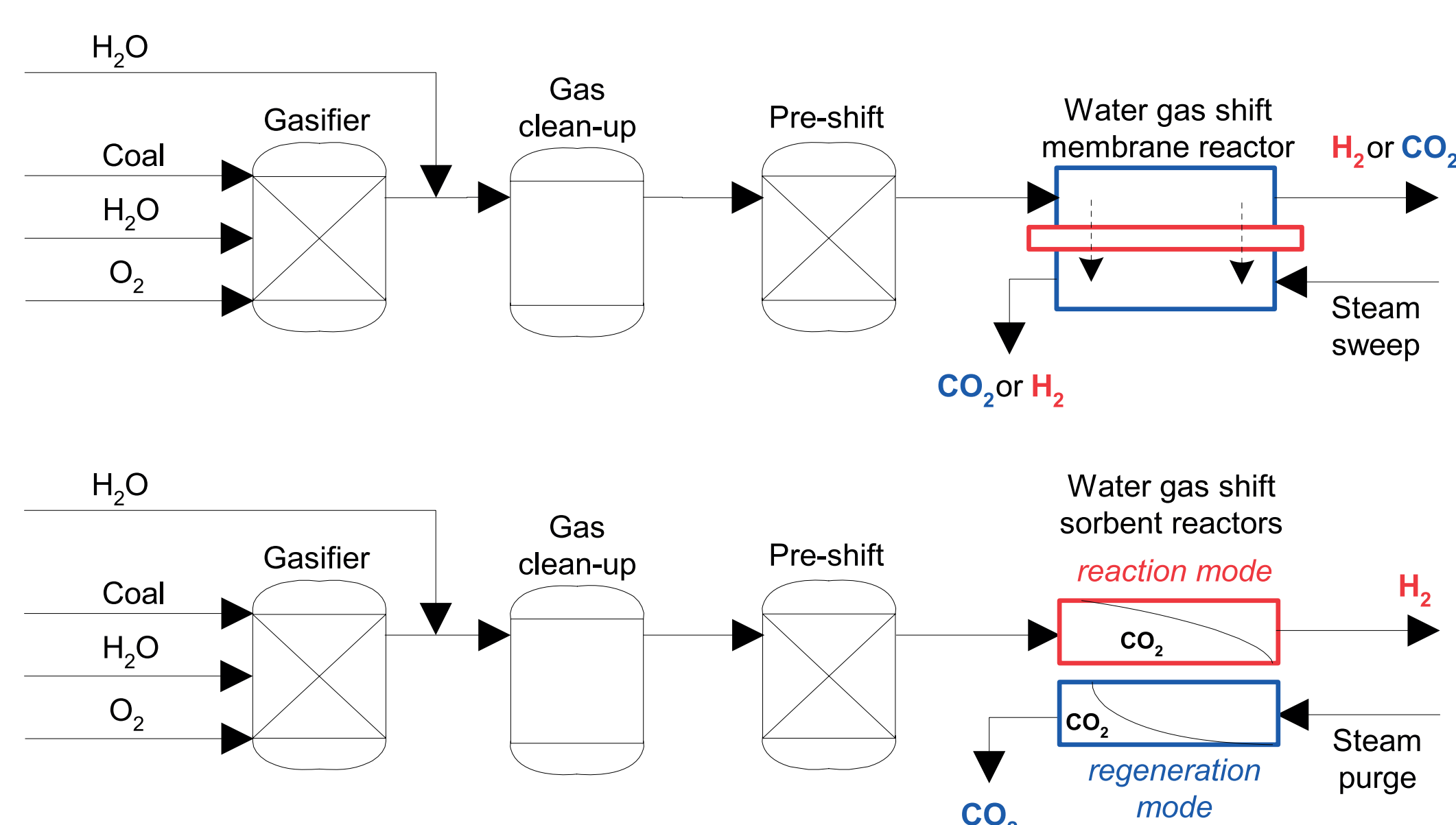


Parallel to this reaction, in a **membrane reactor** the produced CO<sub>2</sub> or H<sub>2</sub> permeates through the membrane, and in a **sorption-enhanced reactor** the produced CO<sub>2</sub> is adsorbed onto an adsorbent.

These technologies can be used for CO<sub>2</sub>-capture in a **Coal IGCC system**. In such a system coal is converted to syngas (CO+H<sub>2</sub>) by a gasifier and then shifted to H<sub>2</sub> and CO<sub>2</sub> in a H<sub>2</sub>/CO<sub>2</sub>-separating reactor, resulting in a **H<sub>2</sub>-rich stream for electricity production and a CO<sub>2</sub>-rich stream for sequestration**.

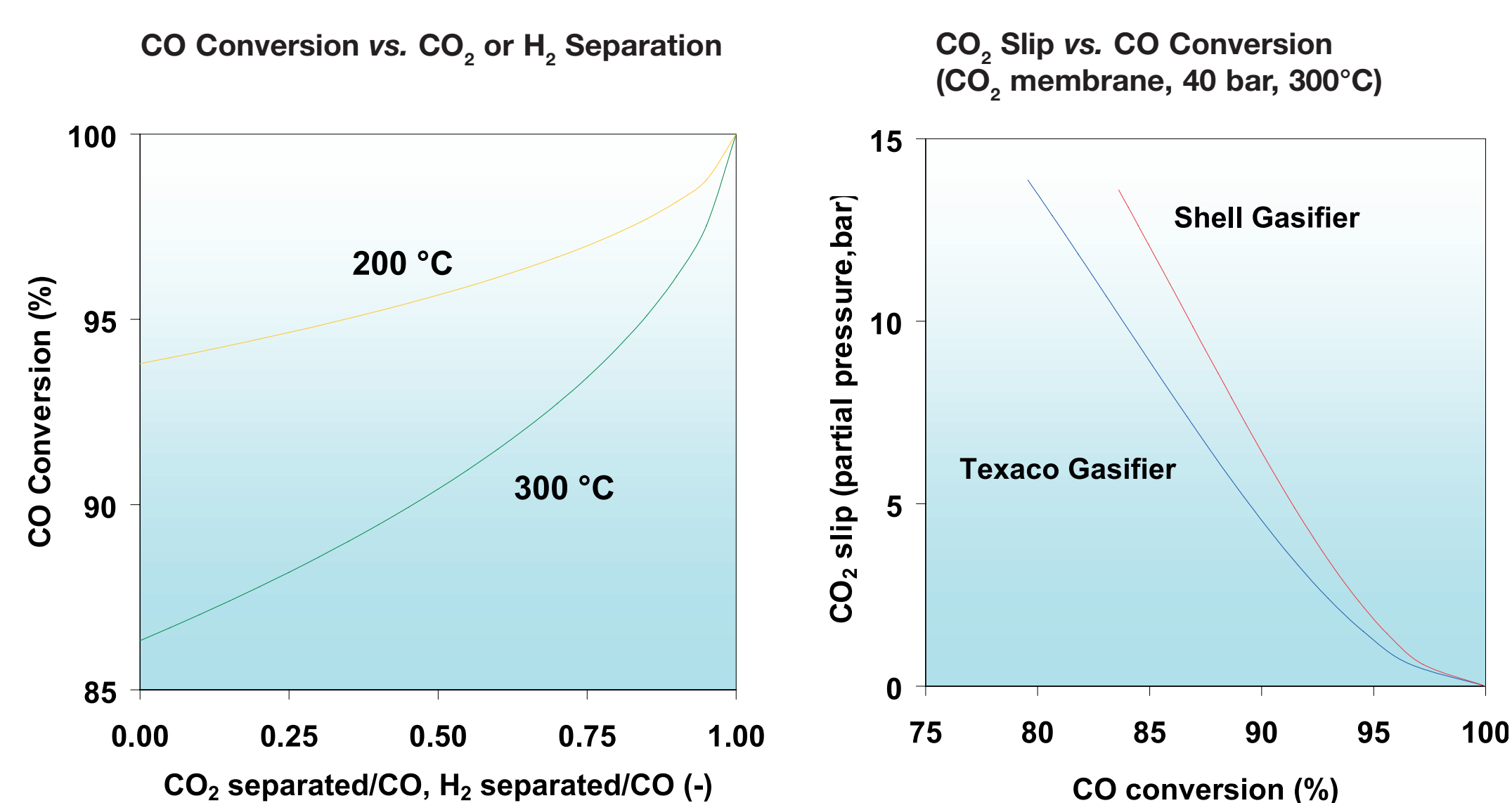
## IGCC Systems with CO<sub>2</sub> Capture

Two possible IGCC system configurations with CO<sub>2</sub> capture; one with a **CO<sub>2</sub> or H<sub>2</sub> separating membrane**, one with a **CO<sub>2</sub> sorbent**. Sulfur can be removed before the shift section (*clean shift*) or after (*sour shift*).



## Thermodynamics: WGS with CO<sub>2</sub> or H<sub>2</sub> Separation

Removing H<sub>2</sub> or CO<sub>2</sub> **shifts the WGS reaction equilibrium** to the product side, resulting in **enhanced CO conversion**.

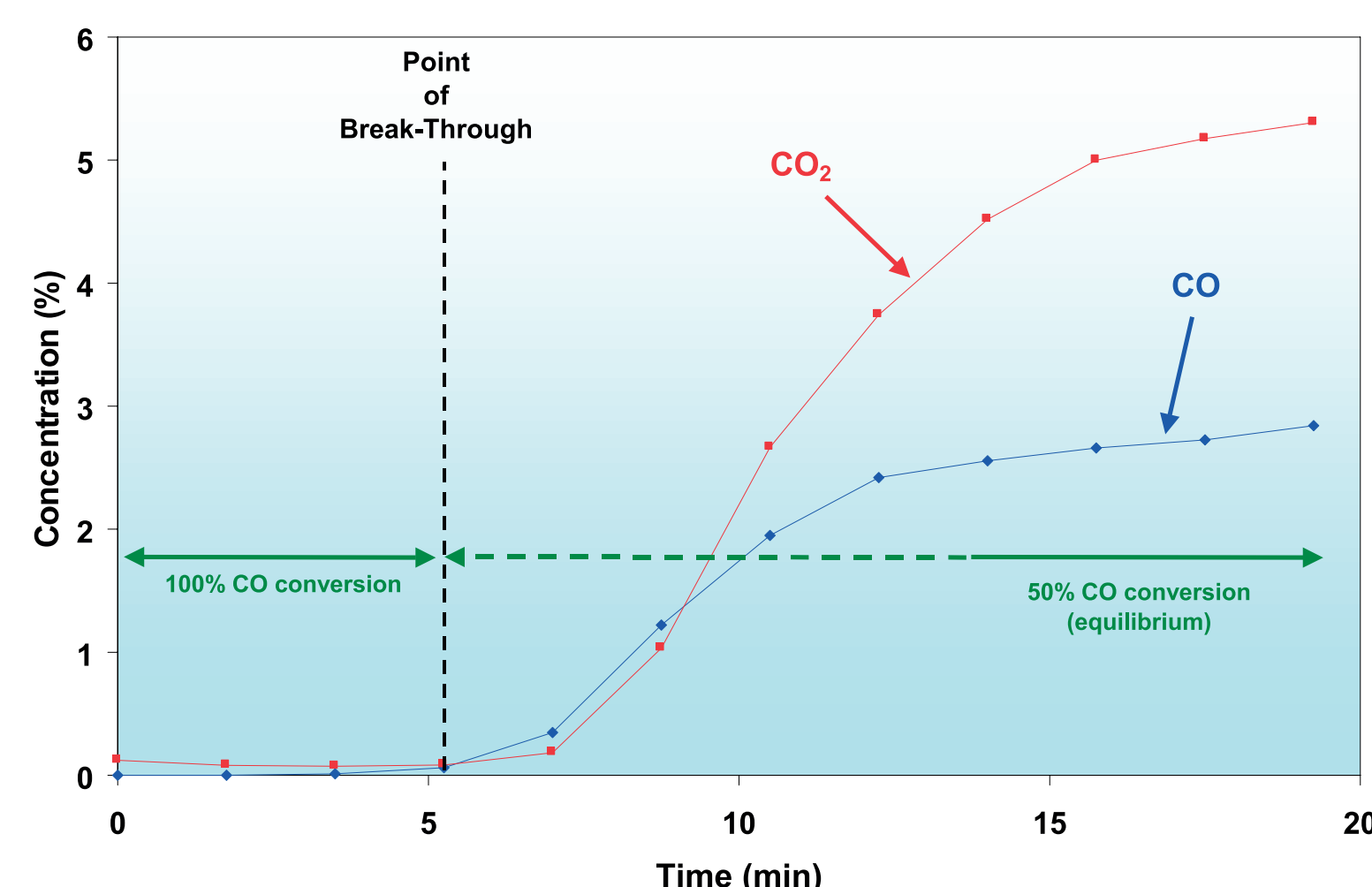


**Left:** Both **temperature** and the **amount of separated CO<sub>2</sub> or H<sub>2</sub>** strongly influence the CO conversion.

**Right:** To increase CO conversion from ~80% to 95%, **CO<sub>2</sub> partial pressure (slip) must be reduced from 14 bar to 2 bar** in a WGS reactor with CO<sub>2</sub> membrane or sorbent.

## Experiments: WGS with CO<sub>2</sub> Sorbents

On lab-scale, **WGS in the presence of a CO<sub>2</sub>-sorbent**, resulted in **100% conversion of CO**. After ~5 min., the sorbent is saturated and CO, CO<sub>2</sub> concentrations in the gas stream rise from 0% to equilibrium. The CO<sub>2</sub>-adsorbent is **regenerated** after 20 min. by purging with steam.



400 °C, 1 bar, 14.5% H<sub>2</sub>O, 2.5% CO<sub>2</sub>, 12% H<sub>2</sub>, 6% CO; Fe/Cr-catalyst; ex-hydrotalcite adsorbent.

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